PROFESSOR WIRTH ON THE EXPERIMENTAL ANALYSIS OF CONSCIOUSNESS.[1]

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The purpose of Professor Wirth's "Die experimentelle Analyse der Bewusstseinsphänomene," as set forth in the Preface, is to give an account of the present status of those part-problems of experimental psychology which Wundt had already formulated for the first time in 1874. This may account, to some extent, for the author's close adherence to the Wundtian system of psychology, a brief résumé of which is offered in the Introduction and the First Part of the book.

The Introduction deals with "Consciousness as a Natural Individual Unity" and begins with a brief sketch of "The Historical Development of the Concept." It then defines and discusses, in somewhat abstract and argumentative fashion, such points as self-consciousness, psychical causality, psychophysical parallelism, and mental dispositions, and concludes with an outline of "The Internal Organization of Consciousness and the Chief Kinds of Mental Contents." Here we meet with the familiar Wundtian dichotomy of *Vorstellungen* and *Gemütsbewegungen* as representing the objective and subjective phases of consciousness. The latter, again, are subdivided into states of passivity or *Gefühle*, with their positive and negative aspects, and into states of activity or *Willenserlebnisse*, with their blind or impulsive and their rational or voluntary aspects. Toward the end of this general outline (p. 17) the author says: "the concept of conscious content is in itself so general as to include the special characteristics of the higher mental functions, such as representation of an object, etc.; and since, in particular, the concrete content is never entirely void of the immediately experienced character of activity, it does not seem necessary to make any special distinction between 'contents' and 'acts.'" He thus takes sharp issue with one of the fundamental positions of the school of Brentano.

The First Part has for its subject-matter "General Considerations Concerning the Nature of Conscious Phenomena." The author informs us here that he means by experimental psychological analysis the attempt "to find, as far as possible, exactly measurable stimuli and unequivocally predetermined voluntary mental attitudes, as the basis for a universally comparable situation of consciousness" (p. 21). The conscious phenomena in the narrower sense, to which, if I understand him rightly, he intends to confine his analysis, are certain interrelations between concurring spatial and temporal complexes and their qualitative and quantitative aspects. The analysis of these phenomena would, however, be incomplete without considering their possible changes in degrees of consciousness. A complete psychological analysis is thus concerned, on the one hand, with a numerical or qualitative determination of the "Enge des

[1] *Die experimentelle Analyse der Bewusstseinsphänomene*, von W. WIRTH, etatmausserord. Professor der Philosophie und Mitdirektor des Instituts für experimentelle Psychologie in Leipzig. Mit 27 Abbildungen im Text und auf einer Tafel. Braunschweig, Druck und Verlag von F. Vieweg und Sohn. 1908, pp. xiv, 449. Price Mk. 11.

Bewusstseins," and on the other hand, with a quantitative measurement of the degree of consciousness of simultaneous processes.[1] With regard to the latter problem, the author thinks that an immediate or direct estimation of the degree of consciousness by introspection is *a priori* doomed to failure, and for two reasons. First, the range of possible degrees of consciousness of a given mental process, with the one of its extremes bordering unconsciousness, "is something purely intensive, and therefore involves all the difficulties of the method of what is called supraliminal differences for intensities" (p. 33). The second and more important objection is the inconstancy of degree of consciousness in succeeding mental states, which destroys all hope of a successful application of the direct method. The actual reason, however, for Wirth's refusal to consider this possibility more in detail seems to the reviewer to be the fact that it had not received a place in the Wundtian programme. At any rate, recent experiments by the present writer with the method of direct estimation of degrees of clearness have shown that Wirth's *a priori* objections do not hold in actual practice. Their rebuttal in this place may therefore be omitted.

In speaking of degrees of consciousness it must be noted that the author distinguishes them sharply from degrees of clearness. "One may best understand the nature of the degree of consciousness by comparing the direct sense-perceptions with the reproduced ideas of memory and imagination referring to like objects" (pp. 34 f.). The difference between them lies in *Lebhaftigkeit* and *Frische*, vividness and freshness. The reproduced processes involve, as a rule, a much greater range of vividness and freshness, though in direct sense-perception, especially in the briefer processes, various degrees of vividness reveal themselves in the stages "des An- und Absteigens der Empfindungsfrische" (p. 35). In the case of the *Gemütsbewegungen*, this vividness manifests itself with great directness "as the real actuality of consciousness" (p. 36). Even so, the author does not commit himself to saying that degree of vividness and freshness is identical with degree of consciousness; they merely "stand in closest relationship to each other" (p. 36). In general, "the degree of consciousness stands so definitely at the centre of all psychical causal developments, that the significance of an element or of any abstract characteristic is always dependent upon it" (p. 36).

In our immediate experience the degree of consciousness reveals its effects in several ways. "The most immediate consequence of a high degree of consciousness in the case of a concrete idea consists primarily in the clear and distinct differentiation of the idea as a whole from the other mental contents, and of its parts and characteristics from one another, while a lower degree of consciousness corresponds to the opposite, an obscure intermingling and confusion" (p. 36). This clearness-effect is much less marked with emotional contents, as they are "very closely fused in content, and less clear than other equally vivid elements can be that are more sharply differentiated from their surroundings" (p. 37). But even in the case of ideational contents, changes in degree of consciousness are only approximately proportional to changes in clearness. Another important consequence of a high degree of consciousness manifests itself in introspection and memory. The degree of consciousness has a determining influence, *e. g.*, upon the duration "des Abklingens eines Inhaltes"

[1] "Das fertige quantitative Resultat der exacten Analyse wird sich also vorläufig immer aus der Angabe der inhaltlichen Basis in ihren oben beigezogenen psychophysischen Massen einerseits und des an jeder Stelle herrschenden Bewusstseinsgrades andererseits zusammensetzen" (p. 32).

(p. 39), or upon the psychophysical disposition for the reproduction of contents or of connection between contents, or upon the certainty and objective correctness of the various reproduced elements, their characteristics and relations. Finally, in a similar way, the range of symptomatic movements will, under simplified secondary conditions, correspond to the degree of consciousness of the feelings expressed by them, just as the course of external voluntary movements will be related to the degree of consciousness of the involved voluntary activity.

Now in every state of consciousness a purposive voluntary activity, a "zielbewusste Willenstätigkeit" (p. 41), is present in one or the other of its various forms. Attention, *e. g.*, is a form of voluntary activity whose complex of impulses aims at the greater clearness of certain ideational contents, especially of immediately perceived objects and events. Comparison, as another function of voluntary activity, "seeks to increase the degree of consciousness of a qualitative relation between contents" (p. 42). A general scientific term for all these forms is found in Wundt's concept of apperception. Under certain conditions, it is true, the apperceptive function of attention may fail to accomplish its aim in establishing a certain clearness-relievo, but it does not therefore lose its character as a voluntary activity. Under certain other conditions, again, certain mental contents may reach a very high degree of consciousness without any voluntary effort, but only on account of a momentarily high excitability of their underlying psychophysical dispositions. The nature and combinations of the particular impulses employed by apperception, and especially attention, for the sake of clarifying mental contents, depend entirely upon the special nature of the contents themselves. On the whole, these impulses work for an exact positive and negative (or inhibitory) adjustment of the body, and especially of the sense-organ involved. The impulses functioning in reproductive apperception manifest themselves, *e. g.*, in expressive movements and in symbolic tendencies of articulation, of writing, etc., but mainly in the internal apprehension and fixation of perceptions and thought-contents. Although an analytic study of the apperceptive activities can trace these impulses separately with more or less definiteness, yet in any concrete experience they co-operate as a whole, with more or less ease according to degree of practice, so that they may lead to a constant level of maximal apperceptive practice which is of cardinal importance for quantitative results in experiments on the degree of consciousness.

These are the general principles and considerations, according to which the author intends to conduct his analysis of conscious phenomena in the concrete, and which serve as his guide in the selection and treatment of the experimental literature. The rest of the work, from p. 56 to p. 443, is in the main a grand review—a connected presentation and a consistent interpretation in the light of the preceding discussion—of certain groups of psychological and related experiments. They are classified in Wundtian fashion as experiments by the impression-method, treated in the Second Part (pp. 56-340), and experiments by the expression-method, taken in the wider sense to include the study of symptomatic, ergographic, and reaction movements, treated in the Third Part (pp. 341-443). A list of nearly 400 names and authors referred to completes the work.

The Second Part discusses in its first half "The Analysis of a Single Moment," and in its second half "The Course of Continuous Conscious Events and the Time-Perception."

Several methods have been developed for the study of a momentary

consciousness. The first is based upon that effect of a high degree of consciousness which manifests itself in retrospection and memory. It employs the simultaneous exposure of several homogeneous stimuli, especially of the visual, tactual, and auditory kind, and presupposes the dual division of a mental state into focus and background, into a high level of relatively clear, and a low level of relatively obscure, mental processes. The problem is identical with the first part of the purpose of a complete psychological analysis, as described above, namely, the numerical or qualitative determination of the range of consciousness and, in particular, of attention; it has been attempted mainly for visual, tactual, and auditory sensations. The author goes into great detail with regard to the temporal relations of the stimulus-exposures, and his refreshing objectivity of treatment contrasts favorably with the abstract and generalizing language of the preceding introductory chapters.

The second method employed in the analysis of a momentary consciousness is called by Wirth the *Schwellenmethode* or the method of the difference-limen. It is based upon the other effect of a high degree of consciousness, namely, upon the clear and distinct differentiation of a given mental process as a whole from other simultaneous contents, and of its essential features or characteristics from each other. The clearness-effect is most nearly proportional to its cause, the underlying degree of consciousness, in the case of the singling out of a particular mental content from its simultaneous and successive neighbors in the same total perceptive complex. This condition is realized, in its most elementary form, in the determination of the difference-limen for a single characteristic, such as magnitude, position, brightness, etc. The unit for measuring the degree of consciousness of any of these characteristics is found in "the objective difference which evokes a judgment of difference of a determinate clearness and certainty" (p. 100).

In order to put this point more clearly, we may follow up one of Wirth's concrete examples. In a uniformly illuminated, monocular field of vision certain places or regions are so arranged that their brightness may be gradually and measurably increased until they are supraliminally different from the rest of the field. The whole unitary field is now exposed for a certain length of time and observed with a predetermined distribution of attention, *e.g.*, with attention to the right half of the whole field, but with fixation held always upon the same point at the centre. After a convenient interval, which is determined by the observer's attentive *Einstellung* or preparation, the field is briefly re-exposed with a certain change in the brightness of some (to the observer unknown) region. The change is gradually enhanced until it becomes just noticeable. It then constitutes the difference-limen for the region in question, and as such is the reciprocal value of the degree of consciousness pertaining to this particular region. A systematic application of the method, under various experimental conditions, and with distribution of attention either to the different characteristics of the total complex or to its various part-contents, requires that the observers be always able to give a constant amount of attention to the whole complex during both exposures without expecting a change in any particular direction. Even then it is possible that the various part-contents or characteristics depend, for their degree of consciousness, upon secondary phenomena; in vision, *e.g.*, upon the peculiarities of the periphery of the retina. It is therefore further necessary, in most cases, to determine the absolute difference-limen for every characteristic or every part-content with maximal attention to it itself, and thus to obtain

what is called the normal value of the limen. This is then compared with the difference-limen found with a given distribution of attention, and the ratio between the two values constitutes a more exact measure of the degree of consciousness for the particular characteristic or part-content in the original perceptive complex. The ratios thus found, for the various phenomena investigated, are reduced to the same base by making each normal value equal 1, so that the smaller ratios or fractions express the higher degrees of consciousness, and conversely.

The actual experimental application of such a method involves many details and complications, according to the sense-department and the nature of the perceptive complex selected. The field most extensively studied in this way is vision. Wirth discusses at some length the investigation of Mittenzwey, who worked out the degrees of consciousness for the characteristics of magnitude, position, and brightness of one and of several small white circles within a large gray circular field. In the case of one variable circle, with attention equally distributed over all three characteristics, Mittenzwey found that, if measured by the ratio between the normal value and the difference-limen, brightness required the highest degree of consciousness, .54, position demanded less, .67, and magnitude as expressed by decrease, .75, by increase, 1.00. This result shows that, in spite of the observers' intention to distribute their attention equally over all three characteristics, their effort is influenced by the relations existing between the phenomena observed. In the case of several small circles, with distributed attention, Mittenzwey found the following values expressing degrees of consciousness: .37 for magnitude, .36 for position, and .58 for brightness. If the observer concentrated his attention upon the same characteristic in all small circles, then the other characteristics did not suffer much loss in degree of consciousness; while, if all characteristics in one circle were attended to, the corresponding values for the other circles rose considerably, and in some cases their degree of consciousness was practically zero. An extensive distribution of attention shows, therefore, even in the case of one variable characteristic, the greater variety of degrees of consciousness. Its study was accordingly made the aim of Wirth's own experiments with the *Schwellenmethode*, which he very briefly reviews and summarizes. His perceptive complex was the uniformly illuminated field of vision of the left eye. It was divided into 37 regions, which were grouped concentrically around the point of fixation, and could be gradually and measurably increased in brightness. Since visual sensations change very rapidly in degree of clearness during the first 30σ of their rise to consciousness (*Anklingen*), it was only necessary to know the time-interval at which an increase became just noticeable, and to use this as an equivalent of the visual difference-limen. Hence the formula for the calculation of the degree of consciousness pertaining to any one of the 37 regions was:

$$\text{D. Cs.} = \frac{\text{Intensity of j. n. R-increment} \times \text{Duration of R}}{\text{Constant Initial Intensity of Region}}.$$

In accordance with this formula the whole left field of vision was investigated, with the centre as constant fixation-point, but with attention distributed in the following different ways: (*a*) to the whole field, (*b*) to the left half of the field, (*c*) to the upper left quadrant, (*d*) to a region in the left upper periphery, and (*e*) to the fixation-point itself. Unfortunately, the results with these different distributions were obtained at various stages of practice, so that they are not comparable. Other obvious disadvantages of the method are the difficulty of maintaining a com-

plicated and constant *Einstellung* of attention which requires more than three months practice even for a skilled observer (p. 128), and the consequent difficulty of multiplying results with other observers and with variations of conditions. The main result of all these experiments is, according to Wirth, that the monocular field of vision shows at any moment only relatively small differences in clearness. In particular, under the most natural conditions, when the fixation-point is also the point of attention, the difference of average clearness for the five concentric zones is hardly appreciable. The average values, from centre to periphery, are: 1.16, 1.23, 1.23, 1.14, and 1.26. Wirth also applied his *Schwellenmethode* to touch, the pressure being varied intensively by means of von Frey's limen gauge. He used six pressure stimuli on the lower right and left arms, on the backs of the hands, and on the upper surfaces of the feet, and the obtained values were: for the right side 1.56, 1.96, and 1.10, and for the left side 1.36, 1.51, and 1.35. For tonal pitches he employed the *C* of 128 vs. with its first four overtones, all 5 tones produced by electric tuning forks. Their intensification was produced by movement of a noiseless cock in the tube conducting the tone to the ear. The values expressing degrees of consciousness for the four partials *C*, *c*, *g*, and c^1 were, for one observer, 1.31, 1.10, 1.16, and 1.16, and for another observer 1.16, 1.12, 1.14, and 1.02. In both instances, attention was distributed over the whole tonal complex.

In this connection Wirth devotes a few pages to the discussion of the method of measuring attention by distracting stimuli, and especially to its application by Peters, whose results, he thinks, are in general and essential agreement with his own.

Another and much more indirect way of determining degree of clearness makes use of its relation to accidental and constant errors of observation and comparison. (It will be noticed with some surprise that in the heading of this sub-division,[1] as well as in various passages throughout the text,[2] Wirth seems practically to identify degree of consciousness with degree of clearness.) Owing to the relative inconsistency of the psychophysical relation between stimulus and sensation, a given stimulus-difference may, under certain unfavorable conditions, remain subliminal, or a given stimulus equivalence may arouse a consciousness of inequality. The range of such accidental variations, or the mean error, is greatly reduced by a correct and "geschicktes Verhalten" (p. 151) of attention. To maintain such an attitude is, however, difficult, especially in the case of liminal determinations with distributed attention, where the characteristic whose limen is to be determined offers a constant point of attraction for attention. At the same time, expectation easily assimilates those characteristics most closely related to the one under observation, in favor of the clearness of the latter. Mittenzwey found, *e. g.*, mutually supporting assimilations between the characteristics lighter-larger-higher, and darker-smaller-deeper. Such interrelations occur most readily in the obscurer regions of consciousness.

Besides these accidental errors in liminal measurements there occur constant errors of assimilation which may be due, *e. g.*, to intentional distraction of attention during momentary exposures of objects compared, or to the associative influences of ideas. These last are especially strong in the illusions of perception, which there-

[1] "Die indirekte Bestimmung des Klarheitsgrades durch seine Beziehung zu den Beobachtungs- und Vergleichsfehlern," p. 147.

[2] *Cf.* "Denn nach allen früheren Ausführungen stehen *Bewusstseinsgrade oder Klarheit* eines Inhaltes und Richtigkeit seiner repräsentativen Funktionen immer in enger Beziehung zueinander," p. 151. (Italics are mine.)

fore lead most frequently to wrong judgments, that is, to judgments of inequality with equal stimuli, and to judgments of equality with unequal stimuli. The extent to which these judgments depend upon the degree of consciousness of the secondary factors involved may be most easily determined, experimentally, by means of the optical illusions. It has been shown, *e. g.*, by Schumann, who made tachistoscopic exposures of the illusory complexes, and by Einthoven, who employed instantaneous illumination in order to eliminate eye-movements, that a lower degree of consciousness (conditioning what has been called an imperfect "apperceptive accommodation") exaggerates the Müller-Lyer arrow-illusion to a considerable extent. A similar effect can be obtained with longer exposures, according to Benussi, by a voluntary control of apperception. Benussi has further shown that, after practice, an apperceptive emphasis or disregard of these secondary factors increases or decreases the illusory effect. The apperceptive control of secondary factors is paralleled by the phenomena of fixation and of conscious, impulsive or voluntary eye-movements, whose influence is particularly shown in the illusions with depth-perception. Analogous phenomena occur with tactual illusions, which, on the whole, require no new principle of explanation. If, *e. g.*, attention is voluntarily directed first upon the place on the skin toward which the hand is moving, and then upon the various successive positions or attitudes of the moving limb, the constant error involved in equating distances or in localizing points upon the skin may become actually twice as large as if the attention is directed upon the act as a whole, so that each co-operating secondary factor can attain only to such a degree of consciousness as is necessary for a fairly correct judgment. The same principle is involved in the familiar phenomenon of breaking up an habitual action by attending to one of its components, a procedure which disturbs the clearness-distribution of the various contents; so long as they remain on a somewhat low, but more or less uniform level of degree of consciousness, their co-operation as members of the same complex is undisturbed. In this connection Wirth also discusses the temporal displacement of two simultaneous or almost simultaneous stimuli due to variously distributed attention. These phenomena may justly be called reversible illusions of the temporal order, and as such may be said to constitute a parallel to the reversible illusions of space-perception. Here again it has been found, by Hamlin, that a well distributed attention or "alert indifference" insures the largest number of correct judgments. One of the secondary factors here involved, but in Wirth's opinion not yet unambiguously described, is the previous voluntary *Einstellung* or vivid anticipatory imagination of either of the two possible temporal orders, or more particularly the rhythmical exaggeration of the imagined interval between the two stimuli. He thinks that a closer study of this factor may, *e. g.*, give a satisfactory explanation of the fact mentioned by Weyer, that out of the 12 possible combinations in pairs of light sound and touch, the two sequences light-touch and light-sound deviated from the general rule governing the magnitude of the difference-limen for temporal displacement.

This completes the discussion of the three methods used in the study of a momentary consciousness. It must, however, be added that clearness-distribution also depends, to some extent, upon the nature of the mental contents themselves, and upon their place in the mental pattern or complex under investigation. This dependence is brought out, *e. g.*, in the familiar psychophysical experiments that investigate the influence of varying quality or intensity

upon the absolute difference-limen with maximal concentration of attention. The most suitable material is again offered by space-perception, especially by the difference-limen for estimation of distances. The uniform proportionality which has been found to exist between given distances and the increments necessary to arouse a judgment of just noticeable difference may be most simply interpreted, according to Wirth, in the following way: "the clearness of every single 'element' involved in the comparison of two extensions and contributing to the consciousness of a total distance, is decreased in direct proportion to (the clearness of ?) the total magnitude. The maximal degree of consciousness necessary for a certain and correct recognition of an objective difference can therefore be obtained only by corresponding enlargement of the absolute difference" (p. 204).[1] The influence of independent mental processes upon the clearness of other independent processes has been shown in the experiments of Sante de Sanctis and of Heymans, and in various investigations of distraction of attention. It has also been studied quantitatively by Benussi, who utilized the errors of comparison in the geometrical-optical Zöllner illusions, with variously colored main and secondary lines.

This mutual influence is removed, if the competing mental processes occur successively at such intervals as by trial are found to be most favorable for its elimination. Furthermore, the mutual disturbance of co-exciting mental processes is sometimes more or less counteracted by the fact that the presence of a rival acts as a sort of spur for attention to the primary stimulus. Finally, it must be noticed in this place that a simultaneous execution of two disparate activities sometimes leads to a change of the one of them from its habitual to a newly-elaborated performance; the recitation of poetry, which by itself takes places as a rule in acoustic-motor terms, may be mainly carried on, if performed together with mental arithmetic, in visual-motor terms.

In the following subdivision of the Second Part the author takes up "The Course of Continuous Conscious Events and the Time-Perception."

The mutual interrelation of simultaneous mental processes is represented, in its most concrete form, not in the momentary cross-section of consciousness, but in the longitudinal division which permits the study of a given mental content during a certain interval of time. The necessary conditions for analysis are, aside from the frequent repetition of the identical complex, voluntary apperceptive activity and the continuity of the content. They are realized, *e. g.*, in the experimental studies of mental work, begun by Kraepelin for the adult consciousness and by Burgerstein for the child's mind. Even the interference from such factors as fatigue, distraction, dislike, etc., serves only to make the general conditions more concrete, that is, more like those met with in daily life. On the other hand, it will ordinarily be necessary to eliminate the observer's time-sense, as an indirect motive to his apperceptive activity, by requiring him to abstract from the idea of time, and by objective control and variation

[1] Sie (eine ziemlich gute Proportionalität des absoluten, eben merklichen Längenunterschiedes zu der Gesamtstrecke) scheint aber nun am einfachsten so gedeutet werden zu können, dass die Klarheit jedes einzelnen an der Vergleichsrelation beteiligten "Elementes" der aufeinander bezogenen Extensionen, das zum Bewusstsein einer Gesamtstrecke beiträgt, direkt proportional zur Gesamtquantität herabgesetzt wird. Der maximale Bewusstseinsgrad, welcher zur sicheren und korrekten Erkennung des objektiven Unterschiedes notwendig ist, kann daher erst einem entsprechend vergrösserten absoluten Unterschiede zukommen."

of the temporal conditions. The quantity and quality of the mental work performed under such conditions are a direct and precise measure of the existing degree of consciousness; a measure which, if necessary, may be refined by use of the error-methods.

When this method is applied to the continuous observation of liminal stimuli, it leads to the well-known phenomenon of fluctuation of attention. In reviewing the literature of this problem, Wirth arrives at the conclusion that the fluctuation of liminal auditory sensations is certainly not due to peripheral adaptation. The latter is, however, much more important for vision. Nevertheless, the great irregularities in visual fluctuations, their frequent coincidence with circulatory and respiratory oscillations, and their similarity to fluctuations of supraliminal intensities, are strong arguments in favor of a central seat of the fluctuation.

The study of the Time-Perception itself contributes to the solution of the general problem of the experimental analysis of mental phenomena two important points. The first concerns the development of the individual temporal idea. We have here the factors (*a*) of temporal position or *Zeitlage*, best represented in consciousness by the briefest kind of impression, (*b*) of duration, (*c*) of articulated succession, and (*d*) of empty intervals or pauses. All of these may occur with the most varying degrees of consciousness, and in this respect they are analogous to the factors involved in space-perception. The methods of measuring their degrees involve comparison of two successive time-intervals, the one of which as a rule must be constant, while the duration of the other may vary. It is impossible to enter here upon a detailed review of Wirth's discussion of the various investigations of the time-sense, and of such related phenomena as rhythm, continuous change of sensation, the question of "sensed time," temporal or stroboscopical illusions of moving and resting objects, and the subjective division of time-intervals into equal temporal distances.

The second contribution to be mentioned is the result of the complication-experiments originally derived from the astronomical "eye and ear method." A precise and exhaustive analysis of the factors determining the limen of temporal coincidence and displacement and the magnitude of the errors involved can be secured only by the application of the method of minimal changes, without knowledge on the part of the observer. The liminal values thus found, under varying experimental conditions, are on the whole in agreement. Greater importance, however, attaches to the magnitude and direction of the error resulting from the variation of conditions. With a practically uniform distribution of attention over the two coincident mental processes, the error of displacement is small and as often positive as negative. The same result is obtained, still more clearly, by systematic and skillful practice and general mental alertness. These correcting influences are counteracted by such factors as the regular repetition of the experiments, which demands a more or less rhythmical *Einstellung*, the direction of the moving hand on the dial of the complication clock, and the introduction of more than two simultaneous, similar or disparate stimuli. The explanation of the fact of displacement was first given by Wundt, and Wirth merely restates it in less clear language.

The Third Part, finally, discusses the experimental methods of expression, used especially in the investigation of the affective and volitional aspects of mental life. There are mainly three of these. The first is termed the symptomatic method, and deals with those involuntary innervations and secretory processes of the body which

indicate or accompany emotional and volitional states of consciousness. The symptomatic factors expressing, *e. g.*, excitement and depression, strain and relaxation, pleasantness and unpleasantness, arise out of complex mental contents which for the moment occupy mostly the vague background of consciousness, while the impulsive factors of a voluntary action belong to those clear contents which form the sharp, tapering parts of a clearness-relievo. The interrelations of these two kinds of factors are very intricate, and are seemingly complicated by the facts of sympathetic co-excitation, or of competitive inhibition of such bodily functions as respiration, circulation, etc. In so far as the co-ordination between the mental states and these physiological factors is established, the observations and measurements of the latter allow us to draw inferences from them concerning the degree of consciousness of the affective and volitional factors whose expressions or accompaniments they are.

The second method, especially suitable to the analysis of the volitional aspect of mental life, is the ergographic. Like the former, it has a physiological origin and parallel, in the experiments on the tetanised muscle-preparation which naturally suggested experiments on the living muscle, and developed for that purpose a long list of such apparatus as ergographs, dynamographs, dynamometers, etc. One great advantage of this over the previous method is the direct introspective control of the voluntary effort exerted under given experimental conditions. Corresponding to the co-ordinated physiological factors entering into the results of the previous method, the ergographic method in its turn has to consider the factors of fatigue and practice as well as those of co-fatigue and co-practice of the muscular system involved, and their relation to the volitional factors. The work performed by certain muscles of the body, under a constant voluntary impulse, is measured by the instruments employed and indicates the degree of consciousness of the effort exerted. These results may be affected by other simultaneous mental processes as well as by simultaneous work of a secondary kind. The co-ordination of mental and muscular work is of especial importance for the analysis of the volitional aspect of consciousness.

The third method, finally, is based upon experiments with reactions in the narrower sense. Wirth's general discussion of the components of consciousness in simple and choice reactions, and of their systematic control, does not present anything novel or strikingly different from Wundt's exposition in the 5th ed. of the *Grundzüge der physiol. Psychologie III.* In the last section of the book, however, Wirth takes up the reaction-experiments conducted by himself and Kästner, in which "the clearness of the stimulus motive or the vividness of the presentation of the selected impulse" is measured by the quotient of reaction times obtained under complex and under simple conditions. But a comparison of the results of the simple reactions with the corresponding results of the *Schwellenmethode* shows that an approximate similarity obtains only during an intermediate stage of practice in reaction, while after greater practice (of about five months) the reaction times with different distributions of attention no longer portray any typical distribution of degrees of consciousness in the general clearness-relievo. This incongruence, Wirth thinks, may be explained by assuming that the time-differences in the reactions are not due to gradual change from minimal to maximal clearness of the perceived stimulus as such, but result from the clearness with which a given stimulus *is apprehended as a motive to reaction.* The hypothesis seems to be supported by the results of the choice or 'disjunctive' reactions, in which the one hand was co-

ordinated with the part of the visual field attended to, while the other reacted to changes in the part not attended to. The retarded reaction times for the latter were due to the delayed co-ordination of the stimulus as a motive to the correct hand.

This account must suffice to serve as an indication of the main contents and chief points of interest of a book which is as rich in detail as it is broad in scope. The interweaving of observation and generalization would only increase the value of the work, if the author's style were less involved and less abstract. As it is, the combination greatly enchances the difficulty of understanding a work whose language is often hopelessly confusing. The author sometimes repeats himself unnecessarily, thus loading his sentences with cross-references and obscuring their grammatical construction; sometimes he coins terms, to be employed in a very technical sense, without expressly defining them; and sometimes he uses familiar words in a very specific connotation without further explanation. For these reasons, the reviewer finds it difficult to enter upon a detailed criticism, as he is unable to judge in how far he has correctly understood and interpreted the work. He disagrees, in general, with the author's definition of degree of consciousness and his method of measuring it, with his treatment of the fluctuations of attention, with his discussion of the nature of apperceptive and attentional activity, and with the general presentation of the emotional and volitional aspects of mental life. The first two points of difference concern matters of fact, which have to be decided by experimental method; the two last are still too closely bound up with theory and hypothesis to allow of the hope of satisfactory solution in the near future. The reader who, for the time being, accepts Professor Wirth's point of view will find the author's presentation and interpretation of his subject-matter thoroughly systematic and consistent. While his standpoint is essentially Wundtian, he has also incorporated various Lippsian elements and even uses terms which remind one of the Austrian school. His knowledge of the history and literature of the science makes his treatment of its experimental development especially valuable, and his work will therefore be appreciated by many as a source-book of psychological methods and references.